Telescience Testbed Pilot Program
First Quarterly Report

Maria L. Gallagher
Barry M. Leiner

September 1987

Research Institute for Advanced Computer Science
NASA Ames Research Center

RIACS TR 87.26

RIACS

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The Telescience Testbed Pilot Program is required to issue progress reports to NASA Headquarters on a quarterly basis. This is the first quarterly report, covering the period April 28, 1987 through August 31, 1987.

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1. INTRODUCTION

The Telescience Testbed Pilot Program (TTPP) is intended to develop initial recommendations for requirements and design approaches for the information system of the Space Station era. Multiple scientific experiments are being carried out, each exploiting advanced technologies and technical approaches and each emulating some aspect of Space Station era science. The aggregate results of the program will serve to guide the development of future NASA information systems.

1.1. PROGRAMMATIC SUMMARY

A contract from NASA to USRA was signed on April 28, 1987. This contract calls for the selection of subcontractors, primarily universities, to carry out various rapid prototyping experiments. It also calls for USRA to assist NASA in the provision of an appropriate infrastructure to support the program.

During this first quarter (April 28 through August 31), the following programmatic activities occurred (USRA and subcontract technical activities are reported below):

(1) A Subcontract Acquisition Plan was developed by USRA and approved by NASA.

(2) In accordance with the Subcontract Acquisition Plan, an Announcement of Opportunity was published and proposals received. A Proposal Review Group was formed which made recommendations as to the proposals to be funded, the amounts of funding, and various technical and programmatic issues.

(3) Subcontracts were signed with the majority of the selected subcontractors.[1]

(4) USRA staffing is in place, with the exception of the Scientist position. The USRA staffing is currently as follows:

Barry Leiner	Program Manager
Deborah Cook	Contracts Specialist
Maria Gallagher	Testbed Coordinator
Michael Slocum	Systems Programmer

A search is underway to fill the Scientist position.

(5) In order to meet the proposed program schedule, an ADPE plan and JOFOC were written in advance of the subcontractor selection. The ADPE plan was based on the overall program requirements and called for the purchase of Sun workstations. This plan was approved. A modified ADPE plan recognizing some unique requirements of individual subcontractors was developed and has been submitted to NASA for approval. (This submission was on September 7, 1987.)

(6) The Sun workstations needed by USRA itself have been ordered and partially delivered.

(7) Requirements for communications infrastructure for the program have been collated. These included both connection to the NASA Science Internet (NSI) and special requirements for individual activities. The NSI requirements were coordinated with the NSI Project Office and it was determined that all campuses can be connected through the use of NSFnet. This was coordinated with NSF.

(8) An initial meeting with subcontractors and appropriate NASA and other personnel was held at Ames Research Center, July 30-31, 1987. A review of the various activities took place and discussion was held on the relationship to Space Station development. A detailed set of minutes was prepared and is out for comments.

(9) A procedure was developed for electronic, informal monthly reports. The purpose of these reports is rapid, informal exchange of information amongst the various TTPP participants. The monthly reports were issued for July and August.

1.2. TECHNICAL SUMMARY

The TTPP is based on a concept evaluation methodology using a user oriented rapid prototyping testbed environment. State-of-the-art technologies and concepts are prototyped for the purpose of evaluating those concepts in a realistic setting. The aim is to evaluate requirements and concepts, as opposed to hardware and implementations. The environment is user-oriented, meaning that the focus is on the role of such technologies in supporting new scientific modes of operation. It is not a single testbed, but rather, multiple experiments, each emulative of science in the Space Station era.

During the past quarter, considerable progress was made in initiating these experiments. Proposals were selected that span the four areas of Space Science: Earth Systems Science, Microgravity Science, Astronomy and Astrophysics, and Life Sciences. These proposals incorporate control of robotics, interactive workstation control of remote instruments, and user-friendly search of remote databases. A full discussion of the status of the various technical activities may be found in Section 3,

[1] At this time, nearly all subcontracts have been signed.

where reports from each of the universities are given.

In Section 2, summaries are given of the activities in each space science discipline, plus a summary of technology-focused activities. These are provided by the volunteer area coordinators.

1.3. PROBLEMS ENCOUNTERED

Only minor problems have been encountered during the past quarter. These are provided for information purposes only. No action is requested from NASA on these items at this time.

(1) Achieving the program schedule requires that needed equipment, particularly ADPE, be in place as soon as possible. Normal procurement delays, coupled with delays associated with the preparation and approval of the ADPE plan, have caused some delay in equipment acquisition. This has not yet adversely affected the program schedule.

(2) Electronic mail has proven to be an invaluable asset in program coordination. However, due to participants being on different mail systems (notably, ARPANET, NASAmail and Telemail), coordination of the mailing lists and assurance of reliability have proven to more difficult than anticipated.

(3) The proposal review process, while extremely productive and resulting in significant strengthening of the program, took approximately two months longer than anticipated. This may result in the need for an extension (at no increase in cost), to allow the subcontractors the full, required time for the individual experiments.

(4) There have been delays in NASA approval of the subcontracts. The impact on the program is unclear at this time.

2. AREA QUARTERLY REPORTS

2.1. EARTH SCIENCES - Jeff Star

This report was extracted from the meeting of the TTPP-ES (Earth Sciences) special interest group held at the University of Colorado. It details our current thinking on the potential field campaign, our 'promises' to each other, and the state of our current efforts.

ADP issues for the Earth Science team include the following:

(1) Sun vs. MicroVax is NOT the issue. We are supposed to be proving concepts, in a rapid prototyping environment. Isn't a goal of the testbed program, overall, to be able to work in a heterogeneous environment?

(2) Communications between the systems, both local and wide- area, and the attendant standards required, are more important than standard pieces of hardware. A key point of the TTPP is to examine the requirements.

(3) Are there still problems in equipment purchase? In particular, those of us considering the purchase of non-Sun workstations are concerned ... it's already late September and we haven't received permission

2.1.1. Jeff Star, UC Santa Barbara

A slide show was presented by Star, demonstrating the first build of the UCSB Browse testbed. UCSB intends to have the testbed online and available for the TTPP collaborators, in early October. A 300- 1200-2400 BPS modem will be utilized, with MNP level 4. Collier of Purdue has offered UCSB the loan of a 9600 BPS USR modem. Sawyer of GSFC asked if NSSDC has seen this: nobody has seen this yet. NSSDC will be briefed this fall. Discussions of catalog interoperability (and the NASA CI working group) followed the presentation. Dedecker of the University of Wisconsin mentioned that he has seen a PC-based image display for DMSP data: Dick Savage at Hughes is the contact. Star will check on this.

The software UCSB has developed, including PC-based image display, is currently available to the TTPP earth sciences team. Participants are encouraged to use the system. E-mail on the details will follow in a couple of weeks. This browse capability is felt to be an important component of a future NASA-wide information system, and relevant to the campaign-mode experiment being conducted under the TTPP. UCSB is also interested in non-procedural software interfaces and catalog query exchanges.

2.1.2. Richard Collier, Purdue

A first goal of Purdue's work this year is to make their extensive field multispectral datasets more accessible. Today, even the is hard-copy. The plan is to put a DBMS together for the dataset on a Sun workstation and to make this system available to the community via Arpanet. A present constraint is that the Purdue's Arpanet connection is heavily overloaded. Hopefully, NSI will hopefully improve the situation. Presently, they intend to use Unify or Ingress, rather than the more-expensive Oracle.

A second goal is to look at communications. Both Purdue scientists' needs for access to other systems, as well as the need of outsiders to access Purdue's resources, are important. The questions revolve around identifying acceptable throughputs and latencies for science users.

A third interest is to act as a remote testbed for OASIS, the operations package developed at LASP for control of instruments on SME.

The fourth interest is the campaign experiment discussed in the original TTPP

proposal. A goal of this meeting is to explore the details of this experiment.

Hansen of the University of Colorado mentioned the ACTS program, which may be able to provide us with a very valuable tool in the next few years.

On another related subject, Purdue could potentially broker Bitnet-to-Arpanet routing for the testbed participants. We need to look further into this question of network interconnections.

2.1.3. Ralph Dedecker, University of Wisconsin

Wisconsin's participation in the TTPP revolves around the McIDAS system as a data source in a testbed environment. The near-term goal is to build a bridge between McIDAS and the NSFNet, which will require both hardware and software development. The main work to be done this year involves making near-to-real-time meteorological data products available to users; a secondary effort involves getting data from the University of Colorado/SME and integrating this data source with their existing system.

To date, they have not worked the standards issues. Some data is now available, via 1200/2400 BPS async, as well as, the Telebit Trailblaser async modems. Making a real-time catalog available is unlikely now, but if standard products are already known, they can be requested when needed. End-to-end PC-based software is now available. A Proteon-LAN, plus a PC/AT as the bridge hardware, plus commercially produced TCP software, will be utilized.

2.1.4. Michael Walker, University of Michigan

The overall question is how the system can enhance the conduct of experiments. Michigan's particular interest is the remote control of a robot, from any of a number of computers on a network. Identified problems include: definition of a generic user interface, and the implications of system response time to an interrupt.

The subject for the testbed is a Fabry/Perot interferometer, which is used to determine atmospheric winds and temperature. This pointable instrument requires real-time control. One of the research questions is how to add a level of autonomy to the system, to allow it to "scan for anomalies" rather than to "point to location x,y, and turn on," in a generic way.

A future testbed experiment could involve operating the Michigan interferometer together with the SME.

2.1.5. John Cowley, University of Colorado

The four areas of interest to Colorado are:

(1) remote access to the SME science database. The key goal is to build some sort of user guide, so that the data base of October 1981 through October 1986 can be accessed by outside users;

(2) data interchange formats and standards (with a particular interest in the SFDU);

(3) the campaign experiment; and

(4) teleoperation of the SME, from Purdue University, as well as Michigan and Wisconsin (and UCSB if appropriate). This experiment can be done with live data.

2.1.6. Sawyer, GSFC

Sawyer provided the TTPP-ES with a presentation on the SFDU. Standard means of describing data are needed in the data interchange process, for questions of data preparation, transfer, and interoperability. Data sets are typically not self-describing, don't obey standards, and are not computer-interoperable.

The major attributes of the SFDU are:

(1) a standard container, encapsulating both data and meta-data ;

(2) a hierarchy of control authorities, with WDC-A as the highest-level authority to register and disseminate standards (data definitions and terms of reference); and

(3) services of standard SFDU software, potentially including a standard interface to applications, a standard data descriptive and interchange language, and support of heterogeneous media and systems.

The SFDU header is a 20-byte type/length/value string, including the control authority ID, class, and a spare field, the field length, and then the data itself.

2.1.7. Conclusions

Final discussion concerned the proposed field experiment. There was a great deal of concern that there will not be sufficient time for a significant experiment during the first year of the TTPP.

The campaign experiment, broadly, is a coordinated experiment designed to focus on a small patch of ground. UCSB has tentatively offered to host the experiment, since they are able to predict a large block of reliable weather. The overall flow of the experiment is viewed as:

(1) preparation and planning:

  (a) analysis of historic data:

    1) multispectral data (UCSB Browse testbed)

2) field reflectance data (Purdue)
3) meteorology (Wisconsin)
4) SME solar and middle atmosphere data (Colorado)

(b) logistics - all

(2) teleoperation - the field campaign itself
(a) real-time meteorology - Wisconsin
(b) real-time solar - Colorado
(c) real-time field reflectance - Purdue
(d) ground-based mapping and accuracy verification - UCSB

(3) teleanalysis - relevant analytic functions at all collaborating laboratories, hopefully available to all.

2.1.8. Assignments

The group has decided to proceed in this general direction, with a final decision to be made at our next meeting, tentatively scheduled for January 15, 1988, on whether a March 1, 1988 field experiment is possible.

2.1.8.1. Purdue (Collier)

There is a rentable version of a field spectroradiometer, intended to look like something on EOS. Rental costs are very reasonable, perhaps $1000/week. Details to follow.

Dial-up or Arpanet access to the Purdue catalog of spectral measurements: goal is 15 December 1987.

2.1.8.2. UCSB (Star)

Consult with RIACS staff about the funding profile. There are rumors that the first year TTPP will have a no-cost extension. If this is the case, we must know ASAP, in order to insure continuity of effort and to permit us to make reasonable plans for our collaborations. We are also all interested in any news about the second year.

Also, make the BROWSE testbed available to the earth science TTPP group. The goal is 1 November 1987.

Also, communicate some brief information on ACTS to the rest of the team.

2.1.8.3. Colorado (Cowley)

Dial-up access to SME database, to be available to the collaborators, goal is 7 November 1987. A primer must be written to help people use the system in that time frame.

2.1.8.4. Wisconsin (Dedecker)

The goal is to provide TCP by December 1, 1987, as well as, async access to meteorological data. Target system is a PC/AT with EGA display, with limited data

transfer capabilities.

All of the team members are charged with accessing each of the other's databases and making useful comments. Time frame for this activity is December/January.

2.2. LIFE SCIENCE - Larry Young

The major activity taking place this past quarter has been the definition of a joint program between MIT and Kennedy Space Center. The testbed is aimed at allowing use by MIT experimenters of the KSC Baseline Data Collection Facility US Labsled. In addition to planning, effort has gone into the establishment of appropriate communication links between MIT and KSC to support video experimentation. It is hoped that these links will be provided by NASA through PSCN.

2.3. MICROGRAVITY SCIENCES - Dick Hahn

During the first quarter, a general approach to the program, and a preliminary plan and schedule for experimentation were put in place. Joint meetings were held between the staffs of RPI and LeRC to assign the division of responsibilities and equipment for experiments. A joint working relationship was successfully established between RPI and LeRC. Studies of necessary equipment and software were made, and orders placed. Initial communications links between RPI and LeRC were studied and solutions to problems which arose were identified.

2.4. ASTRONOMY AND ASTROPHYSICS - David Koch

The first quarter for the TTPP consisted for the most part in getting contracts in place and participation in the meeting at Ames on 30-31 July. Since in most cases there was little opportunity to do more than initiate activities; get the contract in place, evaluate any revised statement of work with regard to the planned activities, identify personnel who will be working on the activities, investigating network statuses and requirements, evaluating CPU procurement, etc., there is very little progress to report other than these programmatic results. Therefore, this quarterly report will consist of providing a summary of various information about the eight Testbed projects in the discipline of Astronomy and Astrophysics. Some of these data are incomplete, may be inaccurate or may be out of date already. However, the plan is to revise this information with each quarterly report but in the mean time provide the visibility as best as possible into these various aspects.

Note: the Discipline coordinator assumes all responsibility for errors or misrepresentations. However, it is requested that each PI update and complete this summary information so that future editions of the quarterly reports can be considered authoritative.

Additionally, suggestions for other information to include will be appreciated.

2.4.1. Cornell University

Principal Investigator: Terry Herter

Collaborators: Caltech-IPAC, NASA-Ames, SAO, University of Arizona and University of Rochester

Objectives: Evaluate teleanalysis requirements, procedures and benefits by remotely accessing the IRAS data base at IPAC.
Develop and evaluate the exchanging of IR array processing software and images amongst SIRTF instrument teams using networks.

Network connections: In process

Mail addresses: herter@crnlastr.bitnet

CPU: Sun likely

O/S: Unix

S/W utilities: X-windows

S/W packages: IRAF

2.4.2. Massachusetts Institute of Technology

Principal Investigators: James Elliot

Objectives: Acquisition of astronomical images from remote ground based telescope (40 mi) using networks for operation, image transfer and data distribution.

Network connections: ARPA/NSF Internet and NSI-SPAN in place.

Mail addresses:

CPU: MicroVax II

O/S: Ultrix

S/W utilities: X-windows

S/W packages:

2.4.3. Smithsonian Astrophysical Observatory

Principal Investigator: David Koch

Collaborators: Cornell University, NASA-Ames, University of Arizona and University of Rochester

Objective: Provide network between telescopes near Tucson and facilities in Cambridge. Remotely develop and maintain software for arrays, transfer data for analysis or access archives for observing support. Develop and evaluate the exchanging of IR array processing software and images amongst SIRTF instrument teams using networks.

Network connections: ARPA/NSF Internet, Bitnet, NSI/SPAN in place (Also require network connections at U. of Az.)

Mail addresses: koch@cfa.harvard.edu, koch@cfa1.bitnet, 17442::koch

CPU: Vax 750, VS2000, MicroVax II, MicroVax GPX

O/S: Ultrix

S/W utilities: X-windows, GNU Emacs, LATEX, MONGO, Ingress

S/W packages: IRAF

2.4.4. University of Arizona

Principal Investigator: Larry Schooley

Collaborators: Allegheny Observatory and University of Colorado

Objective: Simulate remote operation of Thaw telescope as a testbed of observing with the Astrometric Telescope Facility.

Network connections: ARPA/NSF Internet, Bitnet in place, NSI in process

Mail addresses: schooley%arizeVax.bitnet

CPU: MicroVax II

O/S: VMS

S/W utilities:

S/W packages: OASIS

2.4.5. University of Arizona, Astronomy

Principal Investigator: Erick Young

Collaborators: Caltech-IPAC, Comell University, NASA-Ames, SAO and University of Rochester

Objectives: Evaluate the process of distributed software design, development and testing for a spaceflight instrument. Perform remote analysis of archived data. Develop and evaluate the exchanging of IR array processing software and images amongst SIRTF instrument teams using networks.

Network connections: same as UA/Schooley

Mail addresses: eyoung@solpl.as.arizona.edu

CPU: Sun 3/160 C recommended

O/S: Unix

S/W utilities: X-windows,

S/W packages: IRAF

2.4.6. University of California, Berkeley

Principal Investigators: Supriya Chakrabarti and Hale Bradt

Collaborators: Massachusetts Institute of Technology and GSFC

Objectives: Develop approach for common remote operation from the users home institution of experiments (EUVE and XTE) to fly sequentially on MMS "Explorer Platform" with particular emphasis on rapid revision of observing based on near realtime data evaluation. Develop system that is to be used throughout development, integration and flight operations.

Network connections: ARPA/NSF Internet in place.

Mail addresses: jgj@xnet.ssl.berkeley.edu (Garrett Jernigan)

CPU: Sun, MicroVax II

O/S: Ultrix

S/W utilities: X-windows

S/W packages:

2.4.7. University of Colorado

Principal Investigator: Elaine Hansen

Collaborators: University of Arizona

Objectives: Perform teleoperation using OASIS of ground telescopes by multiple users to identify and evaluate issues associated with remote operations.

Network connections: ARPA/NSF Internet, Bitnet and NSI-SPAN in place. Also a unique University of Arizona - University of Colorado satellite link.

Mail addresses:

CPU: MicroVax GPX

O/S: VMS

S/W utilities:

S/W packages: OASIS

2.4.8. University of Maryland

Principal Investigator: Michael A'Hearn

Objective: Automate CCD cameras used for acquisition and tracking of telescopes by developing hardware and software to perform: remote alignment of the millimeter radio interferometer with a CCD; automate the mechanical functions of the CCD camera system; and automate the data taking of an instrument to measure solar oscillations.

Network connections: ARPA/NSF Internet in place.

Mail addresses: wls@suns.umd.edu

CPU: MicroVax

O/S:

S/W utilities:

S/W packages:

2.5. TECHNOLOGY - Barry Leiner

The TTPP involves the use of advanced technology and its role in supporting future scientific requirements. The above sections summarized the various programs from the perspectives of the space science disciplines. However, some of the explorations provide more general functions and are best viewed as underlying technology. In this section, these programs are summarized.

2.5.1. University of Rhode Island

The University of Rhode Island (James Kowalski, Principal Investigator) is investigating the rapid and efficient remote digital access to a central image data archive. To accomplish this, an image format allowing user-specified resolution on retrieval is being used. Ultimately, an intelligent interface is to be developed using inferencing and knowledge-based techniques.

In this initial quarter, a number of images have been converted to the pyramidal format and some in-house demonstrations performed.

2.5.2. University of Colorado

The key to teleoperations is the ability to provide the user a workstation to control the remote experiment. The University of Colorado (Elaine Hansen, Principal Investigator) is developing such a workstation software capability, augmenting the Operations and Scientific Instrument Support (OASIS) developed previously. OASIS is to be used in collaboration with a number of the other testbed participants to investigate various teleoperations concepts.

The efforts this quarter have focussed on building the collaborative activities to evaluate OASIS in support of teleoperations. In addition, efforts have begun to port the OASIS software from a MicroVax VMS environment to a Sun workstation.

2.5.3. RIACS

RIACS (Barry Leiner, Principal Investigator) is integrating available software, both public domain and that developed by the testbed and computer science community, into a telescience workstation. This workstation will provide a base of workstation environment to enhance the developments in the testbed and to demonstrate the utility of such workstations in supporting collaborative scientific research.

During this past quarter, the workstation architecture has been defined and contacts made with developers of advanced capabilities (such as the NSF EXPRES project, providing multimedia electronic mail).

2.5.4. University of California, Santa Barbara

UCSB (Jeff Star, Principal Investigator) is investigating the access to large data sets by providing a capability of remotely browsing through the data, identifying the data sets to be retrieved fully.

During the past quarter, most of the effort was expended in initiating the subcontract and project.

2.5.5. University of Michigan

The focus of the Michigan effort (Richard Volz, Principal Investigator) is telerobotics and the use of forward simulation techniques to deal with the time delays inherent in space/ground communications.

During the past quarter, the system configuration has been designed and installation of communication initiated.

2.5.6. Stanford University

Stanford (Michael Wiskerchen, Principal Investigator) is developing a remote operations center based on workstation technology. This effort is complementary to the Colorado and RIACS activities mentioned above.

3. SUBCONTRACTOR QUARTERLY REPORTS

3.1. University of California, Santa Barbara

Finally, we've negotiated and signed the contract: we are underway.

(1) We have had frequent telemail and telephone communications with our collaborators: Hansen, Collier, Biehl, Davis.

(a) Principal subjects of discussion were:

1) network communications, in lieu of working NSI at all the collaborators' institutions
2) tentative logistics for field work roles of each of the universities
3) date/location for field experiment
4) date/location for team meeting in September
5) UCSB Browse project and relevance to TTPP
6) software exchange

(b) Preliminary concepts:

1) late winter field experiment in Southern California, to be complemented by summer experiment in Year 2 in the midwest; and
2) Purdue and UCSB to try working the UCSB Browse testbed; Purdue possibly to lend modem to UCSB for a time.

(3) Detailed discussions took place within UCSB about potential thesis topics for students which may grow out of TTPP. Two Ph.D. students selected for the team: Kenneth McGuire and Key Ho Bahk. Background material was provided to them to bring them up to speed.

(4) There have been some discussions between UCSB and Colorado staff about the heavy support which seems to be available through TTPP for UNIX workstations, in contrast to the limited support for VMS workstations. In general, we are agreed that a migration to UNIX is desirable. However, we are concerned that those of us with very large investments in VMS-based software are being somewhat left out. For example, Randy Davis at Colorado tells me that there is no ADA compiler for UNIX on the MicroVax yet. We at UCSB plan to migrate to UNIX as some of our favorite commercial software becomes available under it; in the meantime, the small MicroVaxes run VMS cost-effectively, and can be converted to UNIX at minimal cost when it is practical to do so.

3.2. Rensselaer Polytechnic Institute

Since technical effort on this program did not start until late July due to administrative problems, this report covers the activities for the period of July 27 through August 31, 1987.

These activities encompassed:

Personnel assignments
Planning Meetings
ADP equipment study and selections
Establishing specific programs & schedules
Study of communication links
Plan POCC layout & equipment

Each of these will be discussed, in detail, in the following paragraphs:

(1) Personnel Assignments:

(a) At RPI:

Mr. R.C. Hahn, Principle Investigator
Dr. R.H. Doremus, Co-investigator
Dr. M.E. Glicksman, Co-investigator
Dr. H. Wiedemeier, Co-investigator
Mr. B. Herbach, Instrumentation Specialist
Dr. T. Lograsso, Dendritic Growth Scientist
Dr. S. Tirmizi, Dendritic Growth Scientist
Ms. A. Kazmer, Glass Science Scientist
To be determined, Vapor Phase Scientist

(b) At Lewis Research Center:

Dr. T. Glasgow, Manager, MMSL
Dr. C. Johnston
Ms. M.J. Bonner

(2) August was the month for getting the program off and running. A meeting of the Co-I's and P.I. was held to review the general approach to the program and to set a preliminary plan and schedule for the program. Agreement was reached on the goals of the program and the level of effort available under the reduced budget. It is planned to achieve the majority of the proposed tasks by the April 28, 1988 termination date of the contract.

Individual meetings were then held with each of the science groups to set the individual science goals and plans. In these meetings, the capability of the equipment available at LeRC was discussed and details of the experiments to be run on a remote basis were established, consistent with the equipment. Detailed schedules were also discussed.

A meeting with personnel from the RPI computer center was held to discuss the data link services that would be available through that facility. The Center is a node in the NYSERNET system (T1 backbone), which has interfaces (56KBS) with many of the other national networks. At the present time, this service does not appear to be applicable to the LeRC link requirements. Consulting services in networking will be available to the program.

A two day meeting was held between the RPI and LeRC assigned staff, which resulted in some immediate solutions, as well as, detailed plans for the next four months. Specific responsibilities for equipment and tasks were assigned to RPI and LeRC, as appropriate. It was decided that each operation would be self-tested before a communication link was established. Of most importance was the general agreement of the RPI-LeRC working relationship.

(3) The initial meeting the TTPP WG at RIACS held in late July was supported by the attendance of the RPI P.I.

(4) As a result of an internal study at RPI, a decision was made and a purchase order placed for a Sun 3/60G workstation. The "G" (Grey Scale) version was chosen

so that video information could be placed in one OF the windows of the display, in conjunction with commands and data in adjacent windows. In this way, all the information required by this remote operator would be available on one screen. The need for a second, ancillary, computer was also established. The primary purpose of this unit is to act as a communications terminal, which could simulate the vagaries of the anticipated Space Station communication links. The second purpose would be to emulate the LeRC equipment during initial tests before the communication link is established. The choices of a unit for the purpose is currently under study. Since funding is limited and the purchases of equipment other than Sun or DEC seems to be difficult this choice is a difficult one.

(5) As a result of the meetings discussed earlier, the following goals have been established for the initial portion of the program:

(a) Establish and equip POCC at RPI - by Nov. 1987

(b) Initial software for Sun - Dec. 1987

(c) Modify equipment at LeRC - by Nov. 1987

(d) Operate, in situ, equipment @ LeRC - Dec. 1987

(e) Simulated test at RPI & LeRC - Jan. 1988

It was also decided, that for the dendrite growth experiment, an experiment similar to those run in the RPI laboratory would be attempted at LeRC by remote control at RPI. Certain differences will be incorporated to simulate planned space experiments. No robotic (mechanical motion) facilities will be utilized. Where this is required, people at LeRC will respond to RPI commands.

Because of the limitations of the acoustic levitator available at LeRC (under 1G conditions), the plans for the glass/ceramic portion of the program have been modified. No levitation experiments will be performed. Instead, the remote control of heat treating of glass samples will be the major concern. Because visual observation is required and because viewing of a hot object in a hot environment is not a trivial problem, the primary effort of this program will be to establish a workable and useable system of remote viewing. It is the goal of this part of the program to evaluate the potential of remote operation of such experiments.

Specific plans for the vapor-phase deposition phase of this program are yet to be determined, although the equipment available at LeRC in this area seems to be adequate for our use.

(6) Preliminary studies of the required and available communication links between RPI and LeRC clearly indicate that serious obstacles exist in this area. Clearly, real-time, standard rate or digitized slow scan video information is required for our experiments. Standard rate, which will be used very little, is available from satellite services at $500/hr., if we can establish a transmitting station at LeRC (not a trivial task). Receiving capability exists at RPI, although the POCC must be wired to the receiving terminal. Initial planning included the establishment of

9.6 KBS dedicated data link between RPI and LeRC at a cost of $1,000/month. Current packet-switched networks are clearly not acceptable for real-time command because of transmission delays. Transmission of digitized video over a 9.6 KBS link requires on the order of minutes per frame. Obviously not acceptable. We believe that frame rates of 0.5 to 10 per second are required for our use. Two possibilities have been identified as solutions to this problem. One is video data compression which may allow the use of 9.6 KBS line. The cost and effectiveness of this approach are the subject of a current study at LeRC. There is also a possibility that RPI and LeRC could be linked, through the NASA network, by a T1-line. The possibility is being pursued because at these speeds it is possible the packet-switched delays might be minimized to an acceptable level.

(7) RPI has made available, to this program, a laboratory in the MRC building, which will be converted to a simulated POCC. This room is currently being vacated and plans are being drawn for remodeling to contain a control console, as well as, support communication facilities. It is anticipated that this will be completed in Nov. 1987.

SUMMARY

This six week period has certainly been an active one for this program. Some anticipated problems have been solved but other unanticipated problems have surfaced. A very ambitious, perhaps optimistic, schedule has been established for the program. RPI and LeRC recognized the level of effort required to support this schedule and will do all possible to achieve the goals. Our next report, covering a three month period, will reflect our activities to meet these goals and detail progress toward them.

3.3. University of Arizona - Astronomy

The telescience effort at Steward Observatory is part of the coordinated SIRTF study of the requirements for planning and operating a space observatory in a distributed manner. The Arizona investigation consists of three main parts:

(1) The first is an experiment in remote observing using a 64x64 element HgCdTe detector array. The initial goal is the rapid transfer of image data from the observatory, analysis of the observations using on a computer on campus, and return of the results back to the mountain in a timely enough manner to influence the observing program.

(2) The second element is an investigation into the remote accessing of a large astronomical database. The Infrared Processing and Analysis Center (IPAC) at Caltech will be linked with Steward Observatory using existing networks to allow use of the substantial IRAS data base, including infrared images of the entire sky. Additionally, a large number of astronomical catalogs at other wavelengths are available. We plan to investigate the telecommunication requirements for the effective use of the facility at a remote location. Specifically, formats for the exchange of image and graphical data, bandwidth requirements, and the mix of local vs. IPAC processing power will be investigated.

(3) The third element of the investigation involves the development of a common set of software and formats for the interchange of data between the various SIRTF development teams around the country. Specifically, array image data generated at Cornell, Smithsonian Astrophysical Observatory, and Arizona will be interchanged.

The contract work at Arizona has begun with a definition of the hardware requirements for the investigation. The Arizona requirements are:

(a) image processing capability under the IRAF environment;

(b) good telecommunication capabilities via both Ethernet and a synchronous serial links. IRAF is the software package developed at the National Optical Astronomy Observatory (NOAO) and adopted by the Space Telescope Science Institute. Although designed for maximum portability, IRAF still has a large number of machine dependent aspects, particularly for image display. Since the Sun series of workstations has the highest level of IRAF support at NOAO, we have decided on a Sun 3/160C configuration. A request for quotes has been released by the University of Arizona, and we anticipate a final decision in September.

(4) Some time has been spent collecting the NSI data requirements for the University of Arizona campus. Warren Van Nest of the campus Center for Computing and Information Technology will serve as the contact point at Arizona. Since NOAO is part of the University of Arizona local network, their substantial data requirements have been included in the total. Discussions with NSI personnel at ARC indicate an NSI link to Arizona will likely be within the next six months. The slow connect time is a potential problem for the rapid prototyping work of this program.

(5) Data links between the observatory and the campus computer will be made using commercial telephone lines and 9600-baud modems. We have identified the US Robotics Courier HST as a cost effective way to handle the needed data traffic. Since infrared arrays are currently only at the 64 by 64 element level (as opposed to the 800 by 800 pixels for optical CCD sensors), the amount of data in a full image frame is modest. We anticipate a new infrared array from the Rockwell Science Center in October. This array will have 128 by 128 elements and be very similar in scale to anticipated SIRTF arrays. This new detector array will be incorporated in the observing system as quickly as possible. Work is proceeding on the software needed send the image data over the serial lines. The current telescope control computers produce a telemetry stream that includes a large amount of useful housekeeping information such as time of observations, direction of pointing, tracking rates, etc. We plan to include part of this stream as a header for the images to allow an orderly cataloging of the data.

(6) On administrative matters, the contract between USRA and the University of Arizona was signed in mid-August. A full-time programmer, Irene Barg, is now working on the telescience project. The TTPP kickoff meeting in July was attended by E. Young. Finally, we are working to place a subcontract to IPAC for partial support of one of the co- investigators, T.N. Gautier.

3.4. University of Rhode Island

(1) Project Goals: This project has two primary goals:

(a) Our initial project goal is to develop and test software to provide quicker and more efficient remote digital access to a central image data archive using an inexpensive display device and voice grade communications lines. This is to be accomplished by using pyramidal image formats to allow the user to dynamically select the degree of resolution with which all or parts of an image are transmitted, hence reducing the total number of bytes to be transmitted.

(b) Our longer term goal is to extend the above work by applying AI inferencing and knowledge based systems techniques to develop an "intelligent" interface to an image archive. The intent is to enable the interface to infer what the user wants by looking at what he or she actually selects during the initial course of a session, i.e., by looking at extrinsic parameters such as image type, location, sub-region, resolution, etc., as well as intrinsic parameters such as histogram characteristics, etc. The interface will be able, after some "training" at the beginning of the session to select usable images or sub-images and present them or forward them to the user without requiring direct image-by-image responses on the user's part.

(2) Relevant Timetable Dates:

The University of Rhode Island's Graduate School of Oceanography is presently connected via the SPAN Network to most major oceanographic research centers. Many of these centers are using Vaxes, Adage display hardware, and display software originally developed at the University of Miami (DSP System) to process and display AVHRR images. Our first major timetable goal is to have prototype software implementing dynamic resolution and compatible with the present hardware and software ready for initial testing at selected SPAN sites by 29 February 1988.

(3) Project Activities This Quarter:

(a) July:

1) We received formal notification of grant award in early July. The subcontract was signed and in place by the end of July.

2) One of our grad students worked on implemented algorithms to construct image pyramids from raster files.

3) Non-participation at kick-off meeting 7/30-31 due to communications problems.

(b) August:

1) We converted a number of AVHRR images of the New York Bight area into multi-resolution pyramidal format and began some informal in-house demonstrations and tests to see at what resolution level there is enough detail for a user to make decisions as to whether the image is usable or interesting. It seems that a 64 x 64 pixel reduction of a 512 x 512

original often is sufficient to determine general usability of an image for oceanographic purposes.

2) We took delivery of IBM PS/II, which we are going to use as our "inexpensive display device" (see Project Goals, above), and started to work with it.

3) By the last week of August, we seemed to have gotten the communications with RIACS straightened out and we began to communicate with RIACS and TTPP participants via e-mail on a more regular and reliable basis.

4) We are in the process of appointing other project personnel: a graduate research assistant and a part-time programmer.

(4) Remarks:

With the exception of the communications problems mentioned above, there seems to be nothing especially remarkable to report for the first quarter. Most of our initial work involves programming implementation of well-understood techniques. We have not encountered any major problems and we anticipate being able to meet our project goals and deadlines.

3.5. University of Arizona (Schooley)

This is input for the quarterly report from the University of Arizona projects in astronomy (astrometric telescope facility -- ATF) and micro- gravity sciences (remote fluid handling -- RFH.)

(1) The project kickoff meeting at Ames was attended by Larry Schooley (principal investigator) and Terry Triffet.

(2) The subcontract was accepted by the University on August 7, 1987, and the graduate student contracts for the fall semester have been written. The MicroVax II workstation which will be used for control of both projects was installed and tested. A copy of the OASIS software was received from the University of Colorado, and this has also been installed.

(3) To gain familiarity with the OASIS software, we have constructed a replica of their Hero robot observatory model, and have run the LSIS demonstration which controls the robot. The next phase of this learning process will be to demonstrate remote operation of the robot using land lines (dial-up) and high speed (9600 baud) data modems. After that we plan to control the robot at Colorado using an existing NSFnet link at 56Kb/s via satellite.

(4) Meetings are being scheduled for September with appropriate Ames personnel for preliminary planning and design of the ATF and RFH scenarios. This process should be completed during the next quarter.

3.6. Cornell University

(1) During the period from 1 April through 31 August 1987, only moderate progress was made in the TTPP at Cornell and its associated participating institutions, due to delays in obtaining a subcontract between USRA and Cornell University and previous commitments for July and the first two weeks of August by the investigators. A subcontract was signed by Cornell on 23 July and by USRA on 27 July.

(2) This time has been spent evaluating workstations, examining possible communication links, and reevaluating the goals of our program within the TTPP and our methods of achieving these goals, particularly in light of the Telescience kickoff meeting in late July. Unfortunately T. Herter was unable to attend this meeting however a presentation was made on behalf of Cornell by Dave Koch of SAO.

(3) A telecon between SIRTF participants in the TTPP was held 26 August. Participants included Dave Koch (SAO), Erick Young (Arizona), John Stauffer (Ames), Fred Witteborn (Ames), and Terry Herter (Cornell). This telecon followed an Astrophysics Data Workshop (attended by D. Koch and J. Stauffer) which provided additional important input into our decisions.

Issues discussed included:

(a) NASA's breakdown of the levels of data acquisition/reduction for astronomy (based on discussions at the Astrophysics Data Workshop):

level 0: Convert analog downlink data and strip telemetry to give digital, clean instrument data.

level 1: Remove instrument artifacts, e.g. flat fielding, fixing bad pixels, fixing cosmic ray hits, etc. This is further broken down into:

1a <--> reversible processing
1b --> irreversible processing

level 2: Converting to calibrated units, e.g. flux, wavelengths, and physical coordinates on the sky.

levels 3 and up: involve getting the sciences analysis done, e.g. finding fluxes for individual sources, cleaning, etc.

This establishes a baseline on which a dividing line can be drawn between facility processing and remote processing. This line is most likely to be drawn between levels 1 and 2 or levels 2 and 3. Its main impact will be to set the level at which software must be written.

(b) The OASIS software being written at Colorado for instrument control. This software provides a standardized interface between the user and the instrument. The SIRTF team wishes to keep open (and in fact wishes to pursue) the option of adopting the OASIS software. It will be initially developed for a GPX MicroVax machi+1 within the next nine months

Colorado plans to port the package to SUN's.

(c) Computer hardware was discussed and the group decided that (for those purchasing hardware) SUN Microsystems computers would be adopted.

(4) As a result of the SIRTF telescience team telecon, both Cornell and the University of Rochester, will be purchasing SUN Microsystems computers for the TTPP. This is a change from Rochester's original intent to purchase a MicroVax computer.

3.7. MIT, Life Sciences

(1) During the quarter, MIT spent a majority of its effort in defining a workable, meaningful telescience test bed set-up and experiment. Initial efforts at setting up a prototype test bed internally at MIT were discarded due to financial constraints and negotiations with KSC were initiated to gain their collaboration and support in a test bed which would utilize the KSC Baseline Data Collection Facility US Labsled. KSC was extremely receptive to this idea and has agreed to provide the equipment needed to support a test bed utilizing the US Labsled with remote PIs interfaced at MIT.

(2) Means of linking the two sites were investigated, as well as the parameters necessary to allow the testing of various modes of communication. Primary emphasis is given to the requirements for video. Existing software (OASIS) was con- sidered for use in the remote display, existing hardware was investigated for varying frame rate, picture size, and general degradation of the video.

(3) Extensive discussions were held with our subcontractor Payload Systems Inc. concerning experiment planning, means of interfacing, support requirements and experiment conduct. Meetings were held with Dave Clark July 23, to discuss KSC/MIT telecommunications problems and plans for NSI.

(4) Over all this activity, we continued to negotiate with USRA concerning our contract. The initial proposal was completely rewritten to reflect the change in initial direction and to meet cost requirements. The fact that MIT has two test beds in separate disciplines complicates the proposal process. However, the final proposal was prepared and should be in USRA's hands.

(5) Byron Lichtenberg, PSI, represented the Life Sciences at the first Working Group meeting in July.

3.8. Purdue University

(1) The contract between USRA and Purdue University is being finalized.

(2) Larry Biehl began working quarter-time on the project in July and half-time on the project in August. Gary Bass and Mahesh Veerina, graduate students, started working on the project during the week of August 24.

(3) Richard Collier and Larry Biehl attended the TTPP meeting held July 30-31 at Ames and made presentations summarizing Purdue's project.

(4) The status of Purdue's internet connection to NSFnet and NSI was determined. Purdue does not have a direct connection to NSFnet (or NSI). Purdue researchers can get to NSFnet through the ARPANET via gateways at the University of Illinois and Carnegie Mellon. Purdue's network manager contact is Scott Ksander.

(5) Information on several data base management software systems for the Sun Workstation (SunIngress, SunUnify, Oracle, Sybase) and Apple Mac II (4th Dimension, Reflex Plus, Omni 3 Plus, Double Helix, dBase Mac) were obtained for evaluation to be used for the spectrometer/multiband radiometer spectral data base. No decision has been made yet on the system to use.

(6) Information on 'write once read multiple' (WORM) optical disk drives and CD ROM drives for the Mac II and the Sun workstations is being obtained.

(7) The design of the spectral data base dictionary has been started. The spectral data base presently has approximately 250,000 observations. It has been determined that the Planetary Data System data dictionary design would not be appropriate for this data; there would be too much overhead in unused files and fields. However pieces of the dictionary are appropriate. Information is being obtained about the Pilot Land Data System.

(8) The hardware for the project is being evaluated and a list is being made for NASA to approve.

(9) An Earth Science group meeting at University of Colorado in Boulder, Colorado has been scheduled for the end of September.

(10) Dick Collier and Larry Biehl have contacted Jeff Star UCSB concerning a loan of a US Robotics 9600 baud modem to test 9600 baud dialup access to their Browse system which they are developing for the Telescience project.

3.9. University of California, Berkeley

(1) Introduction: The Berkeley Telescience Testbed project is performing three experiments, building on work for the Extreme Ultraviolet Explorer (EUVE) project at the Space Sciences Laboratory (SSL).

  (a) The first experiment is a teleoperation experiment investigating remote instrument control over a network.

  (b) The second is an effort to develop a system for operation of a network (XNET) of remote workstations allowing coordinated software development by widely dispersed groups.

  (c) The final experiment concerns hardware simulation as a method to encourage the concurrent development of instrument hardware and support software. Initial progress has been made on all three experiments.

(2) Teleoperation:

A telemetry reception and commanding system has been designed using the local area network at SSL. This was performed using the KIWI (a "flightless bird" consisting of breadboard EUVE electronics and a spacecraft simulator), along

with software to transmit commands and data over the network. Initial tests have been run between SSL and MIT (by logging in remotely from SSL). Implementation and testing will be carried out over the next three months.

Full-scale tests between SSL and MIT will require better communications throughput. In addition, work has been started on data compression and encryption software. The full-scale tests will be performed after this is complete.

(3) Teledesign (XNET):

(a) Several enhancements were made to the Software Control System (SCS) software, as preliminary steps to establishment of the XNET system. In particular, the SCS was modified to transfer only files which have changed, rather than entire directories, when updating SCS directories across the local area network. This step was necessary to allow operation of the XNET system across the ARPANET to the Center for Space Research (CSR) at MIT, since the link is prone to outages and has fairly low bandwidth compared to our Ethernet LAN.

(b) In addition, the software was modified, so that it would operate correctly on a Vax 11/750, running 4.2bsd connected to the same local area net as several Sun workstations running SunOS 3.3. Only a few modifications to the software were required to make the tests succeed, which increases our confidence that few if any modifications will be required to port to other systems. This current version SCS software has been installed on several Sun workstations running SunOS 2.2 at the MIT Center for Space Research.

(c) We have written test software to transfer data between MIT-CSR and UCB-SSL over the ARPANET. This code is layered on top of the TCP/IP protocols and relies on them for data integrity. One of the things which was discovered in writing this code is that there is at least one gateway between MIT-SSL and UCB-SSL, which will not pass packets with a data field larger than 983 bytes. There was some discussion in the Usenet network news that the problem was, in fact, with Sun's (and 4.2bsd's) TCP implementation, rather than with any specific gateway. We have been unable to resolve this problem but we were able to avoid it, by using a smaller packet size. This test software has run reliably between the two sites for the last month.

(d) The next step will be to repackage this data transfer software with the "borrow" code in the SCS. This will allow files to be shared between UCB-SSL and MIT-CSR. A further step will be to write software which will transfer only changes to files, rather than the entire file. The file transfer software will be designed to work outside the SCS, as well as within it, to increase the number of sites, which will be willing and able to use it.

(4) Teledesign (Simulation):

(a) The first phase of the simulation of the 8085 microprocessors on the EUVE is based on work begun in 1984 using an interpreted programming language called Magic/L developed by Loki Engineering, Inc., of Cambridge, MA. Magic/L is an interactive environment; it was chosen for the emulator because

it would provide a ready command interface for the debugging support that the 8085 emulator would have to provide. This early work included provision for multi-processor emulation, using a simple context-switching algorithm. Work was suspended when the emulator exceeded the capacity of the early version of the Magic/L system then in use.

(b) The current Magic/L system is much improved, so the original emulator can easily be adapted. Operation of the emulator in multi-processor mode has been verified using a pair of simple test programs operating in parallel passing data back and forth through a couple of simulated I/O ports.

(c) The interpretive nature of the Magic/L system imposes severe limitations on the speed of the emulator. The second phase of our emulator project will address this by rewriting the core of the emulator in 68000 assembly language, while retaining the Magic/L as a front-end command processor. This will also build on existing work, that of Steven Rosenthal of MIT, who has written a single processor 8080 cpu emulator.

3.10. University of Colorado, LASP

(1) Program Initiation:

(a) Members of the Telescience Testbed Team at the Laboratory for Atmospheric and Space Physics (LASP) attended the first meeting of the Telescience Testbed Pilot Program held at RIACS/Ames Research Center on July 30-31. These included Elaine Hansen, Principal Investigator; John Cowley, program coordinator and representing LASP's Earth Sciences Testbed; Jack Faber, representing LASP's Astronomy Testbed; and Randy Davis, representing LASP's Technology development. (Alain Jouchoux, LASP's lead for Technology, was unable to attend.) John Cowley presented LASP's plans for the Earth Sciences and Astronomy Testbeds. Randy Davis presented the Technology plans, particularly for developments to the OASIS system.

(b) The contract for the first year of LASP's participation in the Telescience Testbed Pilot Program was signed in mid-August, 1987, to cover the one-year program.

(2) Earth System Science Testbed:

(a) LASP is pursuing three main goals during its first year of participation in the Earth System Science Testbed:

1) establishing data links and providing data-retrieval capabilities for remote access to the scientific database of the Solar Mesosphere Explorer (SME) satellite;

2) providing coordinated data acquisition by the SME satellite in support of a ground mapping campaign proposed by the participating universities; and

3) providing another university group with an OASIS (Operations and Scientific Instrument Support) workstation to allow them to remotely operate a scientific instrument aboard SME.

Success in meeting all of these goals requires a significant effort in evaluating data interchange formats and protocols, particularly those which have been proposed for use in the Space Station missions.

(b) In proceeding toward these goals, LASP is hosting the initial meeting of representatives of the Earth Sciences Consortium subgroup of the Pilot Program, to be held in Boulder, Colorado, on September 23, 1987. This meeting will allow the participants to begin formalizing their goals and methods for demonstrating coordinated scientific analyses among distributed users. The meeting will include technical presentations on such subjects as the Standard Formatted Data Unit (SFDU), which is a prime candidate for information/data exchange among members of the consortium.

(c) A specific effort has been started to quantify and evaluate the current SME scientific database as a prelude to enhancing its description and accessibility to the potential users from the consortium. Modes of access will be coordinated with the participating universities, as initiated in the meeting of September 23.

(3) Astronomy Testbed:

(a) We have developed our plans for the first stage of LASP's Astronomy Testbed, which is the teleoperations of the Sommers- Bausch Observatory's 16-inch telescope at the University of Colorado campus in Boulder. This demonstration will allow remote operations of the observatory by means of the OASIS system. This will provide a testbed to evaluate concerns associated with remote operations and to discover how experiment strategies and user interface designs can enhance such operations.

(b) In later stages, this testbed will be extended to more distant remote operations and to other national telescope facilities. During the first quarter, we have defined the following features of the teleoperations implementation for Sommers-Bausch:

1) Interfaces to the photometer instrumentation
2) Interfaces to the CCD imager - Interfaces to the Apple II telescope controller, including necessary circuit board hardware acquisitions
3) Telemetry packets from the Apple II to OASIS - Telescope features commandable by OASIS
4) The data lines required for implementation - Modifications to the Apple II controller software
5) The user interface to be provided by OASIS
6) The command interface between OASIS and the Apple II
7) The tradeoffs between slow-scan and full-scan video from the CCD imager

(c) A few problem areas have been identified. One is that the telescope's Apple II computer may not have sufficient memory to allow implementing all the features we would like. Any such limitations will become clearer during

September as tests continue. A second problem is that linking into the campus video network, for transmitting the CCD images from the observatory/telescope to the remote user's site, may require a larger part of our hardware budget than was anticipated.

(4) Technologies Testbed:

(a) LASP's goal for the Technologies Testbed is to prototype and demonstrate a key and enabling technology for teleoperations: reactive control and interlocking. This technology is essential in order to allow interactive, distributed user operations; such operations allows for the elimination of ground prechecking of commands.

(b) The testbed for this technology will be an augmentation of the OASIS system to include a prototype of operations management techniques based on reactive controls and lockouts. The capabilities of such an enhanced OASIS will be tested in its applications to operations of the SME satellite and the ground observatory testbeds.

(c) As a related technology effort, the availability of OASIS to other users will be extended by porting the system to operate on a Sun Workstation. (OASIS was developed to be highly portable, but some DEC-dependent features remain.) Toward this end, a Sun Workstation development system is being ordered, and LASP systems personnel are developing their knowledge of Unix. The design of a system- independent OASIS control language parser has also been started.

3.11. RIACS

(1) Hardware:

Based on preliminary evaluations of various vendor equipment, we chose to purchase a Sun 3/140 monochrome workstation with 16 megabytes of memory, a 141 megabyte disk, and quarter inch tape drive as the base level telescience workstation. Subsequent to ordering this hardware, Sun announced a new workstation, the Sun 3/60, which more closely matches the telescience requirements we have established. We are recommending that the subcontractors purchase these workstations.

(2) Infrastructure:

We have developed a preliminary functional description of the telescience workstation and a plan for the initial software infrastructure of this station. RIACS will be providing recommendations for software environments, and will support a loose collection of software for the Sun workstation which will be cheap or free for telescience users. This target infrastructure includes, in part, Sun Unix, Sun Windows, Suntools/Sunview, the C shell, support shell scripts, Gnu Emacs, C, Fortran, possibly Ada, the Rand MH mail handler, Diamond, LaTeX and TeX, as well as the standard Unix utilities. The infrastructure is migrating towards future components, including Mach, NeWS/X.11, Distributed

Object Oriented Programming Environments, Ada, and distributed, transparent resource sharing.

(3) Software Integration:

We are well along in putting together the software infrastructure for the telescience workstation. We have established file system structures and accounts, and developed scripts and data files to provide the telescience user access to the software environment. This environment currently includes Sun Unix, Sun Windows, Suntools and SunView, Gnu Emacs, C and Fortran compilers, the Rand MH mail package, TeX and LaTeX, Frame Maker, and the standard Unix utilities. The Diamond multimedia mail system and various additional utilities will soon be incorporated. We are also formulating recommendations for additional software which may be optionally purchased by the subcontractors, such as the Ada language, data base management systems, and graphical data plotting packages.

(4) Software Development:

In addition to integrating assorted software packages into a coherent system for the telescience user, we are also developing packages and software to enhance the telescience workstation environment. Presently two packages are in place, one provides compatibility in Gnu Emacs to allow ease of use for those familiar with Unipress/Gosling style emacs editors, and the other provides mail handling capabilities to map the simplified and tested RIACS style mail handling into the Gnu Emacs paradigm.

(5) Futures:

Finally, we have brought up the CMU Mach operating system for evaluation as a future candidate for the telescience workstation. We are further exploring the interaction of the current telescience workstation software environment with the X window system. We have also started some exploratory work on a resource sharing architecture and service.

3.12. MIT, Astronomy

This report certainly should include the two monthly reports but also I should say that we have had undergraduate research opportunity project students working over the summer on this project. Their work was with the communication test software and some of the user interface using the X window's. In view of the fact we have not officially started, I think we are doing well.

(1) July Report:

(a) Richard Baron attended the kickoff meeting at Ames.

(b) Though we have not yet signed our contract, negotiations are, I hope, finished. The delay has been due to concerns of the Life Science portion of the proposal for the most part.

(c) We are awaiting information on the software ramdisk that was mentioned by Stanford as being available for the MicroVax.

(d) We are also awaiting word on the reply to our connectivity requirements memo sent earlier.

(e) A final comment on the unreliable mail. It appears there are problems at both MIT and RIACS in establishing e-mail as a reliable method of doing business. The astronomy connection to the e-mail system will be changing in the next few weeks to what I hope is a more reliable system bypassing the use of uucp from another machine on campus.

(2) August Report:

Further study of the final operating system to use on our MicroVaxes. The items of concern are:

(a) compatibility with frame grabber hardware

(b) compatibility with T-1 communications

(c) compatibility with future optical disk usage

(d) image display requirements (shared memory)

Further study on interfacing requirements to Observatory. Start of a low level collaboration with a group internal to MIT. The ccd development group has an operational remote observatory but with a very low data rate link.

3.13. Smithsonian Astrophysical Observatory

(1) Status:

(a) Network hookup: Already have NSI access from previous Roesat requirements. Also, through Harvard have ARPA and bitnet. The link requirements at Steward Observatory necessary to carry out the objectives of the proposed testbed have been included in the overall University of Arizona NSI requirements.

(b) Addresses: Have new arpa address: koch@cfa.harvard.edu. Previous address still valid: 17442::koch on SPAN and koch@cfa1 on bitnet.

(c) Meetings: Participated in the "Astrophysics Data Systems" Workshop in Annapolis on 18-20 Aug. Many of the activities and developments taking place in Code EZ are relevant to TTPP and vice versa.

(d) Hardware: As part of the TTPP there is no plan to buy any computers, although there is other hardware identified for building the network to the mountain identified in the proposal. More on the hardware later in the progress section.

(2) Progress:

(a) As reported last month, a complete evaluation of all of the hardware and other site preparation work for the link to the mountain was completed. Based on that work, all of the equipment necessary for the T1 link has been ordered.

The overall cost is very close that identified in the proposal. Delivery for most of the equipment is anticipated in October.

(b) Following discussions at University of Arizona, the SAO GPX MicroVax at University of Arizona will be moved from a class C connection to a class B connection to provide direct access to the University of Arizona computer center ethernet backbone. Ready access to the SAO MicroVax at University of Arizona will become available once the NSI connection is made there.

(3) Plans for Next Month:

(a) Other than monitoring of the purchase orders and remaining site preparation at Steward Observatory and Mt. Hopkins, there will be limited activity in Sept. The next major work will be take place in October, when most of the equipment will arrive and be installed. Initial link testing should then be possible by the end of October, if the request to the FCC for frequency allocations is approved.

(b) Two meetings will take place in early October: a meeting on Physics and Astrophysics in the Space Station Era will be held in Venice from October 4-7 and a meeting on Astronomy from Large Data Bases will be held in Munich on October 11-13. A paper on this telescience testbed, namely, how telescience will be applied to SIRTF in the space station era, will be written for presentation at the Venice meeting.

3.14. University of Wisconsin

(1) First quarter Telescience Testbed Pilot Program efforts centered on defining program goals and implementation methods, as well as, defining and implementing a cost reimbursement contract.

(2) The initial proposal requested support for approximately $112,000. The initial review by USRA raised a number of questions and comments. These in turn resulted in the submission of a revised proposal which attempted to address these issues and propose a two bridge between the UW McIDAS and TTPP participants that would make McIDAS data products available TTPP participants. The revised proposal again requested $112,000 but with efforts originally intended to evaluate the impact of SME data on the UW sounding retrieval process being reduced in favor of supplying Meteorological data to the Telescience community. Current information indicates that the UW can expect support in the neighborhood of $60,000.

(3) As a result of the funding reduction, current UW plans require the elimination of the acquisition of SME data from CU and the evaluation of the impact of the SME data. The development and implementation of a bridge between the UW McIDAS proNET LAN and the NSFnet is expected to consume most of the funding provided. This bridge is essential if any information is to flow in either direction between the UW McIDAS and any other Telescience participants. The $60,000 available should allow implementation of the bridge and provide resources for a limited dissemination of McIDAS real-time data products to TTPP

participants. It is our hope at UW that further support will allow the UW to implement data ingestion from other TTPP participant data bases into McIDAS as these data sources are identified and their data is made available.

(4) The following July and August monthly report provides further details of work done at UW to date.

(a) Initial TTPP goals were considered and established. An updated proposal was submitted to USRA that addressed questions raised by the review committee and proposed an access method to the McIDAS meteorological data products by Telescience participants.

(b) A reliable (usually) E-MAIL connection was established.

(c) Preliminary operational TCP to UW-McIDAS procedures were evaluated and considered. A preliminary block level design for the NSFnet to McIDAS proNET bridge was defined.

(d) Various TCP commercial software products and ethernet PC bus boards were reviewed and evaluated for use in the bridge architecture.

(e) Ralph Dedecker attended the TTPP meeting held July 30-31 and presented an outline of the submitted proposal, as well as, an overview of the UW McIDAS system and the meteorological data products that are on line.

3.15. University of Maryland

During this quarter year of the investigation, which covers less than two months since the subcontracts were signed, the University of Maryland carried out the following limited activities.

(1) A'Hearn and Zipoy attended the kick-off meeting at RIACS and presented an outline of the goals of the Maryland testbed.

(2) A'Hearn explored the various network connections currently available at Lowell Observatory, the remote site for the operations in the immediate future. This problem is also being explored by Ohio State University personnel who will also be carrying out remote observations at Lowell Observatory. Arrangements are being carried forward for an NSI connection at Lowell Observatory via USGS (which already has a SPAN connection) in parallel with Ohio State's exploration of a leased T1 connection.

(3) A'Hearn and Zipoy explored various possibilities for workstations and submitted an ADPE plan based on the results of those investigations.

(4) A'Hearn also initiated a study of bandwidth requirements for on-line remote target acquisition. This study is not complete.

3.16. University of Michigan

(1) System Configuration and Requirements: The initial system configuration and functional requirements for the telescience testbed has been defined. Our initial testbed configuration will consist of an operator interface located in the Advanced Technology Laboratory, a video and data communication link to the Robotics Research Laboratory, and the Fabry-Perot spectrometer and its local controller in the Space Physics Laboratory. Current work is directed towards the following three areas of investigation.

(2) Design of Operator Interface: The utility of the telescience testbed is greatly influenced by the design of the operator interface. An important item in this is the display of both the returned video from the remote station as well as data. We are currently investigating the existing technology which would enable us to display both video as well as data on the same terminal interface. In addition to the methods used for sensor feedback to the operator, the methods of operator input to the system are being investigated.

(3) Communication Link: The link from the Space Physics Laboratory to the campus computer network is due for completion in the next couple of weeks. The Robotics Research Laboratory is already connected to this system. This connection will give us the means of communicating between computers in the two different labs. An action item on this is the determination of the network needs for establishing a video link between the two labs.

(4) Local Controller for the Fabry-Perot Spectrometer: The Fabry-Perot spectrometer will be controlled with an IBM AT computer. The function of this computer is to collect data to be sent to the operator interface in the Robotics Research Lab, to act on commands from the Robotics Research Lab, and to control the operation of the various subsystems within the Fabry-Perot Spectrometer.

3.17. Stanford University

(1) Activities at Stanford University:

The telescience research activities at Stanford are proceeding in two parts: establishment of computer connections to other sites and development of general applications for use on computer workstations to aid in telescience activities.

(a) The tail circuits for direct 9.6 kbaud links to Goddard Space Flight Center and Johnson Space Center and for a dial-up 56 kbaud link have been completed between Stanford and the NASA Program Support Communications Network (PSCN) at Ames Research Center. The status of these links is discussed below. In addition, the Bay Area Regional Network (BARnet) has recently become operational. This network provides 1.5 Mbaud TCP/IP based communication between Stanford University, Ames Research Center, the University of California at Berkeley and the University of California at Santa Cruz. This capability will be used for research activities between local groups.

(b) Development of general workstation based telescience tools is proceeding slowly, partly because our subcontract with USRA is hung up. We have upgraded the operating system on our Vaxstation II workstations to Ultrix 2.0 and it is connected by NFS to a Vax 11/750 as a file server. The ordering of a SUN 3/160 workstation is pending the subcontract completion.

(2) Activities with Goddard Space Flight Center:

(a) We are in the process of completing communication links between the Data Systems Technology Laboratory at Goddard Space Flight Center and Stanford Remote Science Operations Center. A dual 9.6 kbaud link between the computers at Goddard and Stanford is operational. This link is using the DECnet protocol because these computers are part of the Space Physics Analysis Network (SPAN). The dial-up 56 kbaud link between Goddard and Stanford has been tested, and the computer connections will be operational as soon as the gateway hardware at Stanford and Goddard has been initialized with the necessary network information. The 56 kbaud connection will provide direct communication between the Stanford and Goddard computers over an ethernet interface using the TCP/IP protocol. These links will be used to evaluate the efficiency of real time data transfer between the Goddard Spacelab Data Handling Facility and Stanford.

(b) A second activity approaching operational status is a prototype satellite data broadcast system. The broadcast satellite antenna will be located at Goddard and is scheduled to be installed towards the end of October. The initial receive antenna is already installed at Stanford, but must still be pointed. Both activities are waiting upon the selection of the space segment rental on a communications satellite, which should be finalized in the next two weeks. Goddard is responsible for the data transfer programming while Stanford is responsible for the satellite to computer interfaces. The data transfer systems will be initially tested using the 56 kbaud data link mentioned above starting about the beginning of November. The interface boards for both Vax Unibus and Q-bus computers have been ordered along with a modified communications interface which supports a one way connection using standard data framing conventions. The communication interface board software will be integrated into the data transfer programs during November and December, with the intent of initial operational data transfer over the satellite link to begin early next year.

(3) Activities with Johnson Space Center:

(a) Communication links similar to those connecting Goddard to Stanford are being established to Johnson Space Center in order to provide access to the Space Station End-to-End Testbed facilities. An initial computer connection was established over a 9.6 kbaud land line, but this link has been interrupted for some reason which we are trying to determine. The link should be operational again shortly. An ethernet gateway interface similar to that at Goddard has been installed at Johnson, and a 56 kbaud connection will be made to the Space Station Testbed Payload Simulators as soon as the Stanford

gateway is operational. This link should be ready by the middle of October. The intent of the link is to test remote operations of typical space station payloads in order to establish requirements for necessary data flow, interface standards and commanding capability.

(b) In addition, we have been working with the Johnson personnel to upgrade their Vax computer operating systems to Ultrix 2.0. Two of the computers in use at Johnson were originally purchased through a Stanford cooperative agreement, so that the software and additional memory can be purchased at a reasonable discount through Stanford.

(4) Activities with the University of California at Berkeley:

Discussions concerning joint simulation experiments have been held between personnel at Stanford University and at the University of California at Berkeley. The intent of the experiment is to determine whether a standard campus-wide ethernet system with high speed gateway connections can adequately support real-time instrument control. Currently the group at the Space Science Laboratory is developing software simulations of their instruments to be flown on the Extreme Ultraviolet Explorer. These software simulations will then be run on workstations connected by a local ethernet in order to determine the interaction and control of multiple instruments. Plans are underway to run some of the simulations remotely at Stanford University through BARnet connections, and to have personnel at Stanford interact with instrument simulations running at Berkeley. Guest accounts have been set up at both universities, and the Berkeley software is being brought up on the Stanford computers. Meetings over the next month will more clearly define the interactions and goals of the joint research.